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Terms of trade, debt, and economic growth in a small open economy model

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Abstract. The goal of this paper is to analyze a mechanism that decreases the mobility of labor, capital, and the debt–capital ratio when international prices in the natural resources sector increase, leading to deindustrialization. Through a simulation of the constructed model, we show that the direction of migration between wages is determined by the proportion of labor employed in the natural resources sector, and the trajectory of economic growth within a stable manifold leads to optimal growth. To do this, the government imposes a tax on the production of the natural resource exporting sector and thereby reallocates resources to the industrial sector, thus eliminating the effects of the "Dutch disease."

Keywords: Economic Growth, Optimal Growth, Intersectoral Migration.

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1 Introduction

The international price movements of raw materials influence the economic growth of the countries that export those materials. Thus, a significant increase in demand for these goods by industrialized countries could cause an increase in prices because the supply of raw materials is limited in the short term. That would bring fundamental modifications to the productive sphere of exports due to the reallocation of resources that are made to meet that demand.

If we only take into account tradable goods, which can be exported and imported, in the first instance, a reallocation will have effects on the profitability of the sector and with it the inter-sector labor and capital that moves to face the boom in raw materials (direct deindustrialization). Second, it could bring real exchange rate appreciation. The latter can cause the capital employed in the manufacturing sector to decrease in the short and/or long term (indirect deindustrialization), which would cause a decrease in economic growth.

However, the empirical evidence is not conclusive since booms in international prices and raw materials would not jointly bring a long-term growth decline in trade due to their multiple effects, among which the market channels and the fiscal policy used by local governments can slow down or accelerate deindustrialization.

The case in which the relationship between raw materials and economic growth is negative has been called the "curse of natural resources," while if the relationship is positive, it can be called the "blessing of natural resources." For example, Rodriguez and Sachs [1] suggest that countries rich in natural resources have had slow growth compared to those economies without substantial natural resources.

Sachs and Warner [2] also state that economies with an abundance of exported natural resources, in terms of gross domestic product (GDP), tend to grow more slowly than economies with a shortage of these goods. Similarly, Sala-i-Martin et al. [3] analyze 32 variables for a sample of 98 countries between 1960 and 1992, which may be related to economic growth, and find a negative relationship between economic growth and the ratio of primary exports to the rest of exports. However, the exchange rate distorts the relationship with income growth, and this produces a negative effect. On the other hand, the mining–GDP ratio produces a positive effect on economic growth.

Otherwise, Sala-i-Martin and Subbramanian [4] diagnose that market mechanisms and orientation have little to do with profits from natural resources. They attribute the natural resource curse to government corruption, at least in Nigeria. Likewise, Gylfason [5] and Ploeg [6] point out that institutions and legal norms play an important role in ensuring that countries with abundant resources have economic growth in all their productive sectors.

Also, Caselli [7] suggests that the curse of natural resources operates through the conduct of the political elite, which generates a power struggle; this causes the group in power to make few investments in productive sectors that significantly affect the development of countries with an abundance of natural resources, and this favors little economic growth.

In contrast, Lederman and Maloney [8] review the impact of the commercial structure—basically, the specialization of the natural resources, their export, and intra-industry trade—in economic growth. They conclude that there are no robust results to affirm a curse of natural resources since, in their estimates, they find a positive effect for exports of natural resources. Also, Papyrakis and Gerlagh [9] positively relate the abundance of natural resources with the economic growth of the United States in the period from 1986 to 2003. They conclude that an abundance of natural resources does not contradict growing industrialization for that country. They also establish that the natural resource curse is due to weak institutions, which are common in underdeveloped economies.

In the theoretical literature, models with two sectors are generally developed to analyze the effects that the use of natural resources has on economic growth. There are a couple of characterizations about the behavior of natural resources. The first is as an exogenous variable that directly affects the production function, which is fundamental in the economic growth rate; see Stijns [10] for example. Another characterization is through a functional form that establishes the degradation of natural resources since these are non-renewable and exhaustible; consequently, there are limits to the long-term economic growth trajectory, as is the case of Groth [11].

Typically, a model with two sectors considers that a traditional one appears, based on forms of production with land or agriculture, and a modern one, specifically the industrial or manufacturing sector. For example, Guillo and Perez Sebastian [12] show that a world economy oriented towards agricultural and non-agricultural production could positively or negatively affect the long-term level of economic well-being, depending on the laxity of production factors (see also Guillo and Perez-Sebastian [13]). Also, Roldos [14] presents a model in which a capital imported good is accumulated or consumed while the primary good is exported, with this characterization reflecting the majority of the countries that are dedicated to exporting their primary goods. In his model, one of the sectors uses land and labor (export sector), and the other, capital and labor (import sector).

The model presented here is small and open to the international trade in goods and assets with two sectors: an export sector of raw materials and another manufacturing importer sector. Consequently, the prices of the exportable commodity of raw materials and of the importable manufactured good are given by the world market. The production function of the raw materials and manufactured goods have constant returns to scale. The production of raw materials is consumed and exported. The goods of the manufacturing sector are accumulated and consumed. Part of the capital is financed by the world market, given the capital's mobility and its immediate and cost-free arbitrage, so the domestic interest rate is equal to the world interest rate. The government imposes a production tax on the raw materials sector. Tax revenue is distributed to households through lump-sum transfer. Households save a constant fraction of their disposable income. The most important result of the model is that deindustrialization can be curbed through a lump-sum tax on the production of the raw materials sector, making it less profitable. Whit this, it is possible to reallocate work and profits from the raw materials sector to the industrial sector, improving the growth rate and eliminating "Dutch Disease."

2 The formal framework

The objective of this paper is to analyze the effects of the increase in international prices on the reallocation of resources and the economic growth of a small and open economy. However, the results of our model are an extension of Casares et al. [15], which show the influence of the agricultural sector goods boom due to international markets; with this, the increase in relative price causes an instantaneous reallocation of the labor employed in the sector, a decrease in gross national income, an increase in private debt, and a decrease in the stock of physical capital (this last is called direct deindustrialization by Corden and Neary [16]). To counteract the effects of the "Dutch disease,"[1] the government levies a tax on the production of the export sector. Thus, it is possible to reverse the levels of work, gross national income, private debt, and deindustrialization.

[1] According to Edwards and Wijnbergen [17], the Dutch disease is the relationship between the natural resource discoveries and the structural problems of an economy. Originally, the name was assigned because in 1970, the Netherlands discovered oil, which brought with it an appreciation of the country's real exchange rate, causing negative effects on industrial sectors due to the loss of competitiveness.

The analysis of the article by Casares et al. [15] is restricted in the sense that the effects studied are long-term because the model does not have transition dynamics since the variables of interest "jump" from one stationary state to another in the face of changes in the price and tax parameters. This excludes the possibility of studying the short term and the adjustments of the trajectories over time. The proposal presented in this paper is to introduce two adjustment mechanisms, one for labor and one for the debt-equity ratio.

Although there are works devoted to sectoral labor migration (see Chapter 9 of Barro and Sala-i-Martin [18] or Weil [19]), basically, the idea is that the labor force tends to move from economies or sectors with low wages or other adverse economic or non-economic considerations (poverty, violence, corruption, among others) towards economies with high wages and other favorable considerations. We follow Mas-Colell and Razin [20], who analyze the trajectories of migration from the rural sector to the urban sector in the growth of a dual economy. To do this, they specifically introduce a function that models the rate of change of the level of migration over time; thus, there is no longer an instantaneous transfer of work between sectors. Therefore, migration is determined by economic forces (wages, capital, productivity), thereby preventing wages from being assigned by other types of forces, for example, institutional ones.

On the other hand, following Villanueva and Mariano [21], it is possible to study how large amounts of debt have diverted scarce resources from investment and long-term growth. Their purpose is to study the joint idea of the dynamics of external debt, capital accumulation, and economic growth. They find that a continuous increase in the external debt-to-GDP ratio will lead, in the short or long term, to liquidity problems and, in the end, insolvency. Therefore, this ratio is seen as a sufficient condition for sustainability: an economy would be left in a solvency situation if the external debt-GDP ratio did not grow.

As in Mas-Colell and Razin [20] and Villanueva and Mariano [21], in our paper, we show that the direction of migration between wages is completely determined by the proportion of total workers employed in the natural resources sector and that external borrowing decisions, at any instant in time, are a percentage of the net debt stock. The speed of which is the proportional discrepancy between the adjustment of external capital and the expected marginal product and the world interest rate.

3 The model

Our model can be summarized as follows:

$$Y_A(t) = A_A F^{\alpha} L_A(t)^{1-\alpha} \tag{1}$$

$$w_A(t) = (1-\tau)(1-\alpha) p_A A_A F^{\alpha} L_A(t)^{-\alpha} \tag{2}$$

$$R_F(t) = (1-\tau)\alpha p_A A_A F^{\alpha-1} L_A(t)^{1-\alpha} \tag{3}$$

$$Y_M(t) = A_M K(t)^{\beta} L_M(t)^{1-\beta} \tag{4}$$

$$w_M(t) = (1-\beta) A_M K(t)^{\beta} L_M(t)^{-\beta} \tag{5}$$

$$R_K(t) = \beta A_M K(t)^{\beta-1} L_M(t)^{1-\beta} \tag{6}$$

$$L_A(t) + L_M(t) = L(t) \tag{7}$$

$$\frac{L_A(t)}{L(t)} = n(t) \tag{8}$$

$$\frac{\dot{n}(t)}{n(t)} = \frac{w_A(t) - w_M(t)}{w_M(t)} \tag{9}$$

$$\tau p_A Y_A(t) = T(t) \quad (10)$$

$$I(t) = \dot{K}(t) \quad (11)$$

$$d(t) = \frac{D(t)}{K(t)} \quad (12)$$

$$\frac{\dot{d}(t)}{d(t)} = R_K(t) - \delta - r^W \quad (13)$$

Equation 1 is the Cobb-Douglas production function of the raw materials sector. A_A is the productivity of the sector and is constant and exogenous; F is the quantity of a natural resource, the supply of which is fixed; L_A is the number of people o hours employed in the sector; and $\alpha \in (0,1)$ is a constant that measures the participation of the quantity of the natural resource in the product of its sector. If we define P_A as the constant world price of the raw materials and consider P_M as the price of the manufactured good, letting $P_M = 1$ we use the manufactured good as the numeraire[2], so the relative price of the raw materials is in terms of the manufactured good or "terms of trade," defined as $p_A = P_A / P_M$. So, Equations 2 and 3 are the marginal productivities of labor and raw materials, respectively.

Equation 4 is the Cobb-Douglas production function of the manufacturing sector. A_M is the productivity of the sector, which is constant and exogenous; K is the physical capital; L_M is the number of people o hours employed in the sector; and $\beta \in (0,1)$. Equations 5 and 6 are the marginal productivities of labor and manufacturing, respectively.

Assuming no population growth, Equation 7 is the constant share of labor in the natural resource and manufacturing sectors among the total population; accordingly, Equation 8 is the labor market balance. Equation 9 represents intersectoral labor migration based on wage income and is taken from Mas-Colell and Razin [20].

Equation 10 is the government income derived from imposing a tax on the production of the raw materials, $\tau \in (0,1)$, and T is transferred to households. Equation 11 is the gross investment, which is equal to capital accumulation on time.

D is the stock of debt and K is the stock of capital in a period of time, and d is the debt-capital ratio. Equation 12 is taken from Casares et al. [15], and it captures how much debt the economy has per unit of capital stock. Equation 13 is taken from Villanueva and Mariano [21] and represents an adjustment cost to net external borrowing, with a depreciation rate, $\delta \in (0,1)$. This equation says that the growth rate of the debt-capital ratio must be the gap between the net rate of return of a unit of capital and the world interest rate r^W.

3.1 The markets

In order to get aggregate investment–savings equality, we propose Equation 14, where income equals household spending:[3]

$$p_A Y_A(t) + Y_M(t) - r^W D(t) = p_A C_A(t) + C_M(t) + I(t) - \dot{D}(t). \quad (14)$$

The two first terms in the left side of this equation are the income of the household for factor services and the last is the amount of debt interest; the first term on the right side of the equation is the expenditure in consumption of raw materials, the second one is the expenditure in the manufactured good, the third one is the investment volume, and the last is the change in debt

[2] Starr [22] can be reviewed for the concept of numeraire.
[3] Equation 14 expresses the market equilibrium, the IS version of the national accounting identity.

volume. Now, we can define household consumption as a fraction of household income, $(1-s)$ and $s\in(0,1)$, and if we substitute this into Equation 14, we get Equation 15:

$$s(p_A Y_A(t)+Y_M(t)-r^W D(t))+\dot{D}(t)=\dot{K}(t), \tag{15}$$

where $S_H(t)\equiv s(p_A Y_A(t)+Y_M(t)-r^W D(t))$ denotes the household's savings.

3.2 The reduced model

By successive substitutions, from Equation 15 and Equations 1–13, the extended model reduces to a system of three differential equations in $K(t)$, $n(t)$ and $d(t)$.

$$\frac{\dot{K}(t)}{K(t)}=\frac{s\left(p_A\dfrac{A_A F^{\alpha} n(t)^{1-\alpha}}{K(t)}+\dfrac{A_M K(t)^{\beta}(1-n(t))^{1-\beta}}{K(t)}-r^W d(t)\right)}{1-d(t)}-\frac{\delta}{1-d(t)}+\frac{\dot{d}(t)}{1-d(t)} \tag{16}$$

$$\frac{\dot{n}(t)}{n(t)}=\frac{(1-\tau)(1-\alpha)p_A A_A F^{\alpha} n(t)^{-\alpha}-(1-\beta)A_M K(t)^{\beta}(1-n(t))^{-\beta}}{(1-\beta)A_M K(t)^{\beta}(1-n(t))^{-\beta}} \tag{17}$$

$$\frac{\dot{d}(t)}{d(t)}=\beta A_M K(t)^{\beta-1}(1-n(t))^{1-\beta}-\delta-r^W. \tag{18}$$

Long-run equilibrium is obtained by setting the right-hand side of the reduced system (Equations 16, 17 and 18) to zero. With Equations 6 and 13, it is possible to know the level of K. Now, it is possible to find the level of n if we substitute Equations 2 and 5 into Equation 9, which is the static condition of efficient allocation of labor in both sectors. It is also possible to obtain the optimal level of *d*, in addition to the timely substitutions for the steady-state solution for K^*, n^*, $(1-n^*)$ and d^*, which are:

$$n^*=\left[(1-\tau)p_A\left(\frac{A_A}{A_M}\right)\left(\frac{1-\alpha}{1-\beta}\right)\left(\frac{r^W+\delta}{\beta A_M}\right)^{\frac{\beta}{1-\beta}}\right]^{\frac{1}{\alpha}}F \tag{19}$$

$$1-n^*=1-\left[(1-\tau)p_A\left(\frac{A_A}{A_M}\right)\left(\frac{r^W+\delta}{\beta A_M}\right)^{\frac{\beta}{1-\beta}}\right]^{\frac{1}{\alpha}}F \tag{20}$$

$$K^*=\left(\frac{A_M\beta}{r^W+\delta}\right)^{\frac{1}{1-\beta}}(1-n^*) \tag{21}$$

$$d^*=\frac{p_A A_A F^{\alpha} n^{*1-\alpha}}{r^W K^*}+\frac{r^W+\delta}{r^W\beta}-\frac{\delta}{r^W s}. \tag{22}$$

It is also possible to find the gross national product (GNP), it is defined as gross domestic production minus net factor payments ($r^W D$), that is:

$$Y^*_{GNP}=p_A A_A F^{\alpha} n^{*1-\alpha}+A_M K^{*\beta}(1-n^*)^{1-\beta}-r^W d^* K^*=\frac{\delta K^*}{s}. \tag{23}$$

3.3 Stability and Dynamics of the Model

In order to evaluate the stability of the model, we proceed with the following steps: a) we derive the equations with respect to $K(t)$, $n(t)$, and $d(t)$; b) we evaluate the found derivatives in the neighborhood of the steady-state given by k^*, n^*, $(1-n^*)$, and d^*; c) we construct the corresponding Jacobian matrix; and d) we establish whether it is an attractor, a source, or a saddle point. To do this, we assume the same values of the parameters that appear in Casares et al. [15], which are $A_A = 1.2$, $A_M = 1.2$, $F = 1$, $\alpha = 0.3$, $\beta = 0.4$, $\delta = 0.03$, $s = 0.18$, $r^W = 0.03$, $\tau = 0$ and $p_A = 2$. In this case, the linear approximation in the vicinity of the steady-state is a saddle point; this because the Jacobian matrix

$$J = \begin{bmatrix} -0.04474918678 & -0.4856875116 & -0.2049108831 \\ -0.002485363583 & -0.3795316345 & 0 \\ -0.0003999776210 & -0.01279928388 & -0.00000000001 \end{bmatrix},$$

has both positive and negative real eigenvalues, as in Agarwal and O'Regan [23]. The number of decimal digits included in J is sufficient to show that the component J_{33} is different to zero.

After verifying that the eigenvalues of the Jacobian matrix imply a saddle point steady-state, we know the qualitative nature of the dynamical system around the steady-state but nothing about the path that the economy follows towards the steady-state as time passes. Now the problem becomes determining the initial values (initial value problem) of the solution of the dynamical system that enable to attain his steady-state level as time passes without limit in order to compute the time path of the rest of the variables of the model and that establish the growth path towards the steady-state, this is in the stable manifold (local quantification). This approximation is only valid in a steady-state environment. According to Barro and Sala-i-Martin [18], it is possible to determine these values using two alternative methods: i) solving the numerical system by transforming the nonlinear system into a linear one and thus finding the initial points; or ii) using "the time-elimination method" by Mulligan and Sala-i-Martin [24], which consists of finding a policy function of the linearized system. Here, we opt for the first method. The solution of the system given by Equations 16, 17 and 18 with the numerical values given is

$$K(t) = K^* + C_1\mu_1 e^{-\lambda_1 t} + C_2\mu_2 e^{-\lambda_2 t} - C_3\mu_3 e^{\lambda_3 t} \tag{24}$$

$$n(t) = n^* + C_1\gamma_1 e^{-\lambda_1 t} + C_2\gamma_2 e^{-\lambda_2 t} - C_3\gamma_3 e^{\lambda_3 t} \tag{25}$$

$$d(t) = d^* + C_1\psi_1 e^{-\lambda_1 t} + C_2\psi_2 e^{-\lambda_2 t} - C_3\psi_3 e^{\lambda_3 t} \tag{26}$$

with $K^* = 26.6927$, $n^* = 0.1659$, $d^* = 0.2966$, $\lambda_1 = 0.383151283828349$, $\lambda_2 = 0.0426347171302414$, $\lambda_3 = 0.00150517952858974$, $\mu_1 = 0.824215155069584$, $\mu_2 = 0.999947110983829$, $\mu_3 = 0.978580584642433$, $\gamma_1 = 0.565931711403365$, $\gamma_2 = 0.00737683251293642$, $\gamma_3 = 0.00638292274820776$, $\psi_1 = 0.0197655301390986$, $\psi_2 = 0.00716642010834716$, and $\psi_3 = 0.205765151709575$. Only C_1 and C_2 values were determined to calculate the stable manifold. Once the numeric system has been solved (completely), it is possible to calculate the solution path of the rest of the variables, especially those that appear in Equations 19–23 and 15; the paths of the endogenous variables are shown in Figure 1, and the paths of households' savings and GNP are shown in Figure 2.

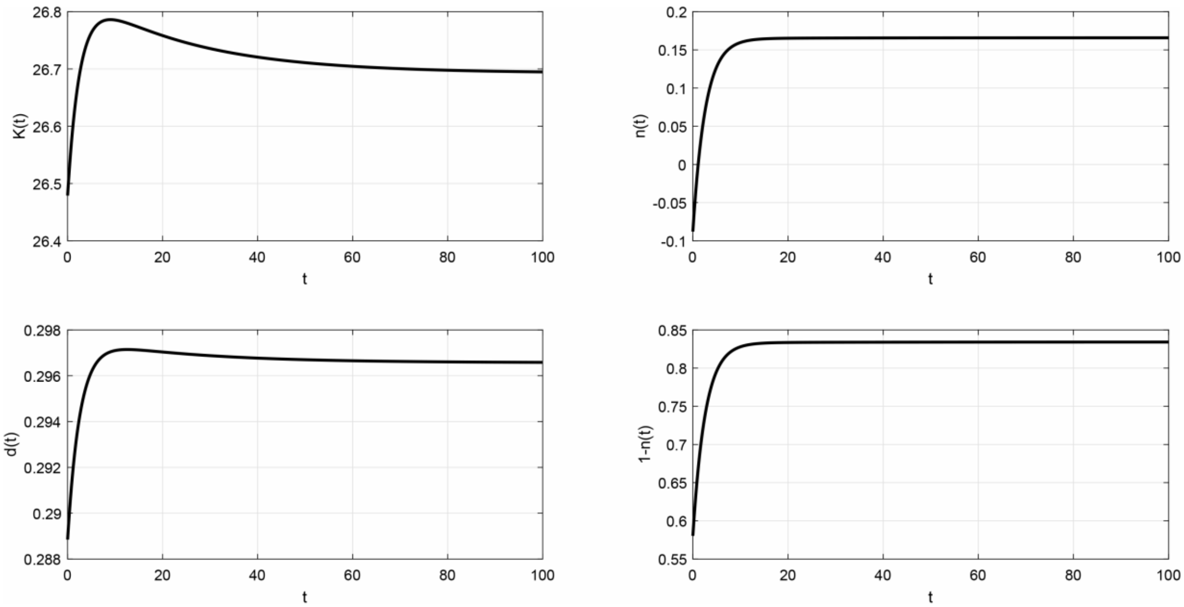

Fig. 1. Numerical paths of $K(t)$, $d(t)$, $n(t)$, and $(1-n(t))$.

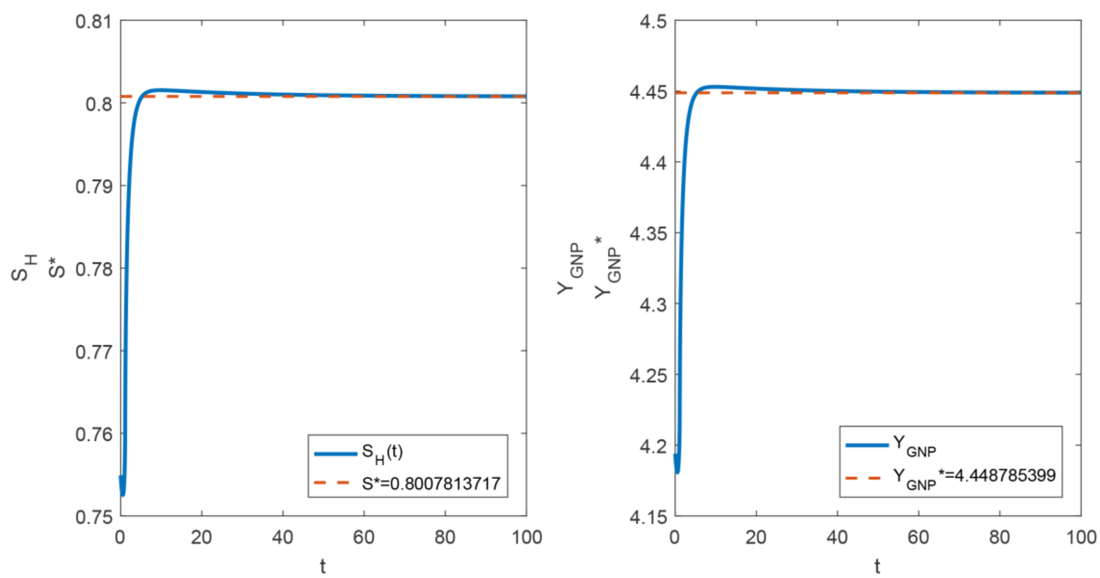

Fig. 2. Numerical paths of S_H and Y_{GNP}.

3.4 An increase in terms of trade and the government response

We will continue assuming that there is no government intervention, which means $\tau = 0$. Furthermore, we will assume that we are in long-term equilibrium. If the economy faces an increase in terms of trade due to a commodity boom (that is, an increase in p_A in Equation 19), we have $\partial n^* / \partial p_A > 0$. This causes an increase in n^*, because the wage in the raw materials sector (product value of marginal labor in the sector) is momentarily higher than the wage in the manufacturing sector. Thus, jobs flow instantaneously from the industrial sector to the raw materials sector, which in turn reduces the level of labor resources by $(1-n^*)$ (Equation 20), $\partial(1-n^*)/\partial p_A < 0$. Figure 3 shows the transition dynamics and the new long-term allocation of labor.

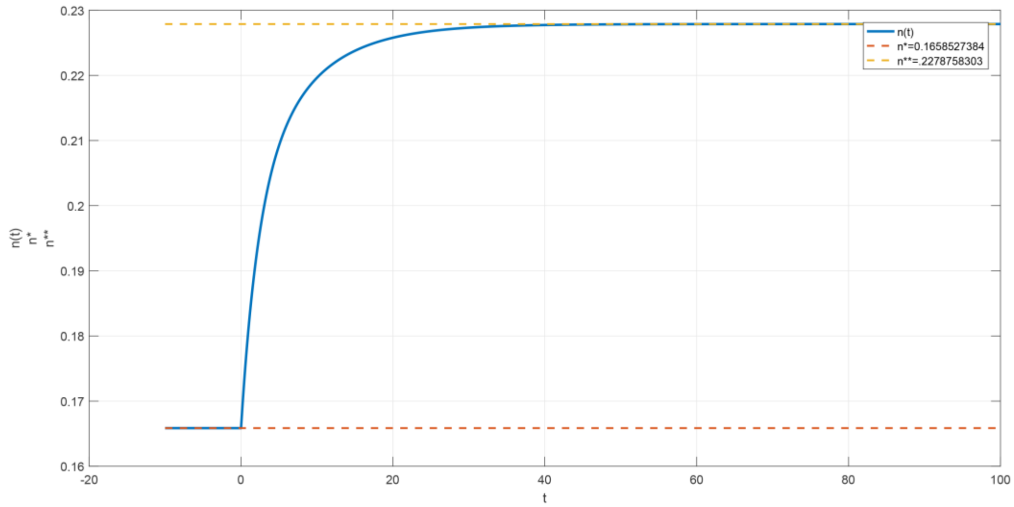

Fig. 3. Transitional dynamics of $n(t)$ against an increase in terms of trade.

Equation 21 also presents modifications, since as the wage increases in the raw materials sector, the rate of the population employed in the manufacturing sector decreases, that is, $\partial(1-n^*)/\partial p_A < 0$, and with it, the steady-state capital, $\partial K^*/\partial(1-n^*) < 0$. This indicates that an increase in p_A leads to a decrease in K^*. The decrease in $(1-n^*)$, K^*, and manufacturing production is what is known by Corden and Neary [16] as direct deindustrialization. Figure 4 shows this decrease. When the terms of trade increase, the debt-capital ratio in the steady-state also increases, which means $\partial d^*/\partial p_A > 0$, that part of the capital is externally financed. Figure 5 establishes the dynamics of the debt transition.

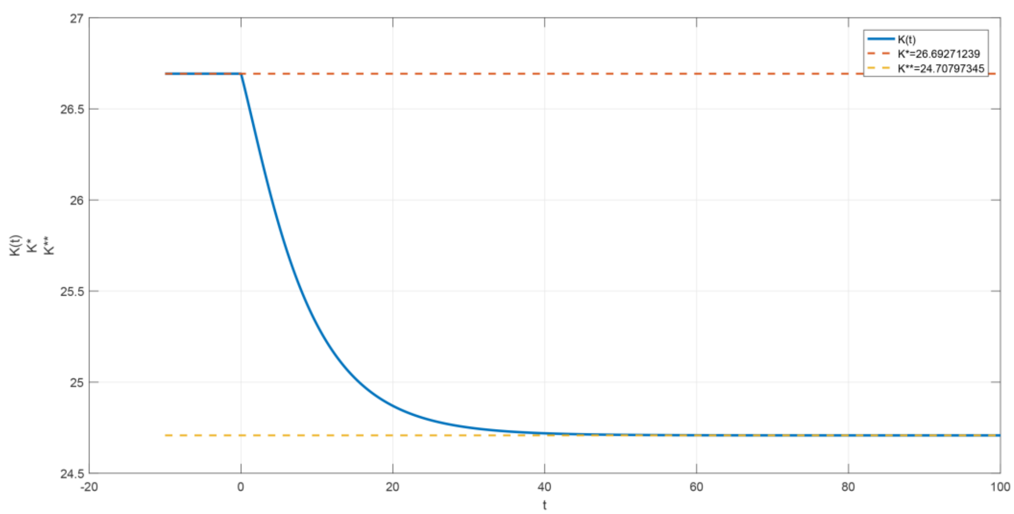

Fig. 4. Transitional dynamics of $K(t)$ against an increase in terms of trade.

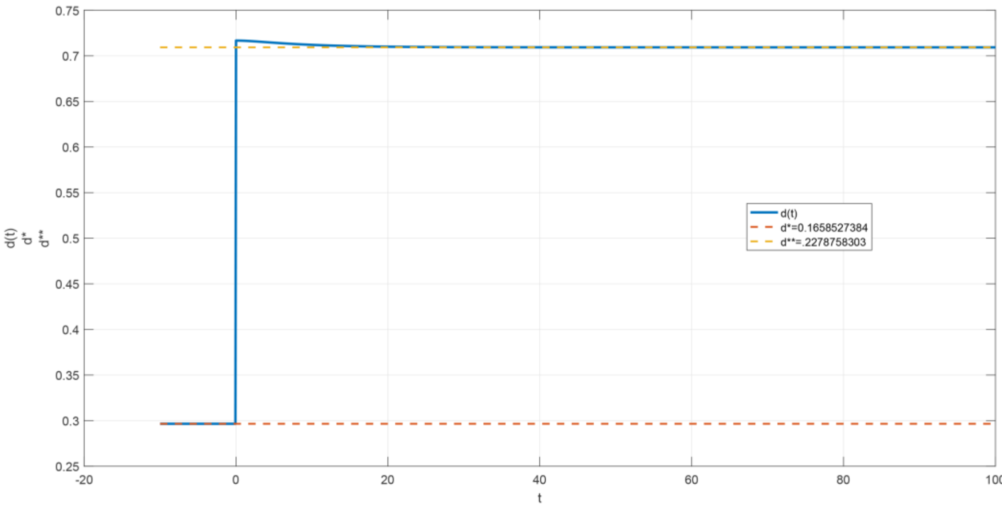

Fig. 5. Transitional dynamics of $d(t)$ against an increase in terms of trade.

Finally, if $\partial K^* / \partial p_A < 0$ and $\partial Y_{GNP}{}^* / \partial K^* > 0$, then $\partial Y_{GNP}{}^* / \partial p_A = (\partial Y_{GNP}{}^* / \partial K^*)(\partial K^* / \partial p_A) < 0$. This means that when the terms of trade increase, gross national production declines. In the steady-state, the decrease in capital contracts savings is because there was a decrease in $Y_{GNP}{}^*$. It is concluded that when the terms of trade increase, $(1-n^*)$, K^* and $Y_{GNP}{}^*$ decrease and d increases. With the data referred to in the previous section, we can show a numerical simulation to explain how the economy goes from a steady-state to another one. If the levels of the parameters are kept, the numerical results are $n^* = 0.1659$, $(1-n^*) = 0.8341$, $K^* = 26.6927$, $d^* = 0.2966$, and $Y_{GNP}{}^* = 4.4487$. By increasing the terms of trade from $p_A = 2$ to $p_A = 2.2$ the numerical solution of the steady-state is $n^* = 0.2279$, $(1-n^*) = 0.7721$, $K^* = 24.7080$, $d^* = 0.7093$, and $Y_{GNP}{}^* = 4.1179$. The rate of labor in the manufacturing sector decreases from 0.8341 to 0.7721, and the capital stock decreases from 26.6927 to 24.7080 (see Figure 4). Since in the steady-state, the equality $sY_{GDP}{}^* = \delta K^*$ always holds, when capital decreases, saving is also reduced because gross national income has been reduced, accompanied by an increase in d^*. Therefore, $Y_{GDP}{}^*$ decreases from 4.4487 to 4.1179 and d^* increases from 0.2966 to 0.7093, as shown in Figure 5. Notice that capital jumps from one steady-state to another because no capital adjustment costs are introduced.

Given the deindustrialization, the government responds with an increase in τ later. With Equation 19, we obtain that $\partial n^* = \partial \tau < 0$, and for Equation 20, we have $\partial(1-n^*) = \partial \tau > 0$. By increasing the tax τ, the wage in the raw materials sector is momentarily lower than the wage in manufacturing; then, in the transition, the labor in the manufacturing sector increases until it is allocated at the long-term level (see Figure 6). Therefore, government intervention reallocates labor among the sectors via wages.

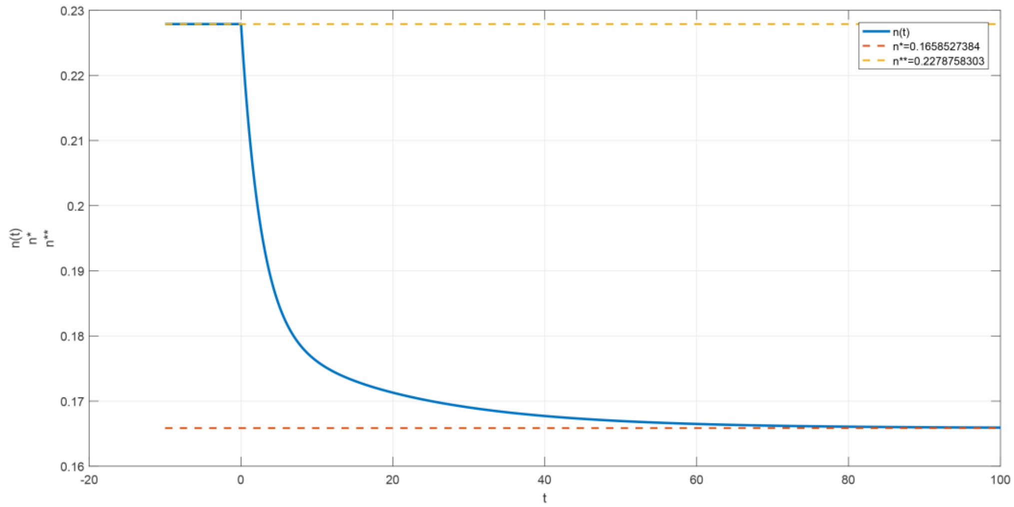

Fig. 6. Transitional dynamics of $n(t)$ against an increase in τ.

Using Equation 21, we have $\partial K^* / \partial \tau = (\partial K^* / \partial(1-n^*))(\partial(1-n^*)/\partial \tau)$, and with this, $\partial K^* = \partial \tau > 0$ is determined. Therefore, the increase in the tax rate at production causes the level of K^* to increase. As $(1-n^*)$ and K^* increase, the deindustrialization is reverted (see Figure 7).

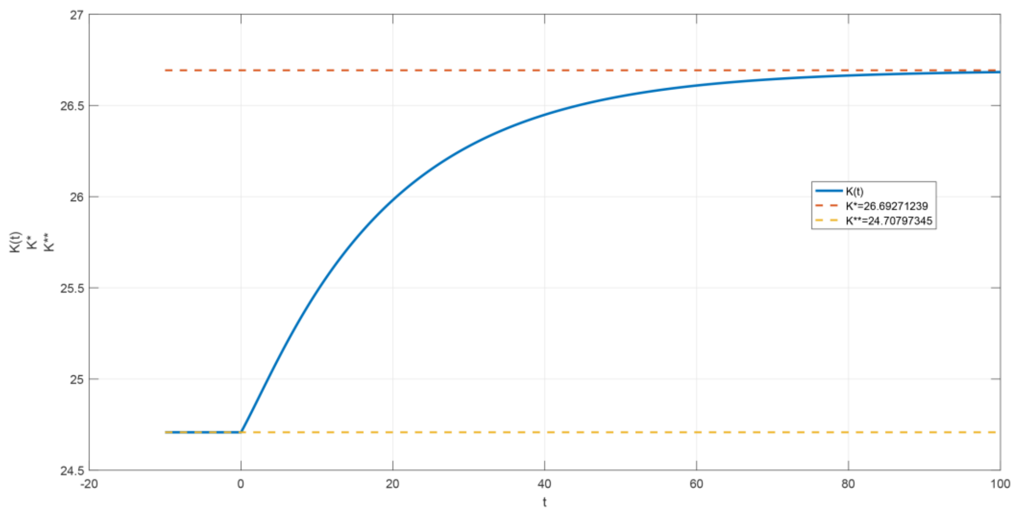

Fig. 7. Transitional dynamics of $K(t)$ against an increase in τ.

With respect to d^*, we check $\partial d^* / \partial \tau < 0$, that is, an increase in τ yields a decrease in d^*. As $\partial Y_{GDP}{}^* / \partial \tau = (Y_{GNP}{}^* / \partial K^*)(\partial K^* / \partial \tau)$, then an increase in the production tax rate increases $Y_{GDP}{}^*$. As $sY_{GDP}{}^* = \delta K^*$, with an increase in capital, saving has to increase by means of an increase in gross national income, with a decrease in d^*, although it does not return to the initial situation. The conclusion is that increasing τ increases the values of $(1-n^*)$, K^*, and $Y_{GDP}{}^*$, that is, the deindustrialization is corrected while d^* decreases. Considering the same level of the parameters but with $p_A = 2.2$ and τ = 0.0909, we obtain $(1-n^*) = 0.8341$, $K^* = 26.6927$, $d^* = 0.3818$, and $Y_{GDP}{}^* = 4.4487$ ($\delta K^* / s = 4.4487$). It is observed that the proportion of labor in the manufacturing sector, the capital stock, and gross national production are the same as when

$p_A = 2$. While d^* decreases from 0.7093 to 0.3818, the level of K^* is the same as when $p_A = 2$ (see Figure 8) because $p_A = 2.2$ and d^* do not appear in Equation 21.

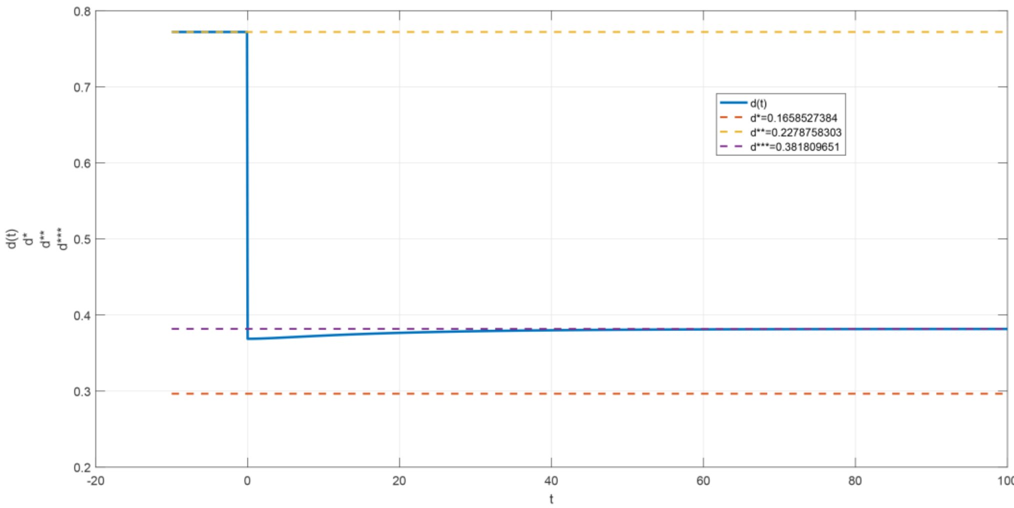

Fig. 8. Transitional dynamics of $d(t)$ against an increase in τ.

4 Concluding remarks

Based on Casares et al. [15], an expanded growth model has been built with two sectors to study direct deindustrialization. The extension consists of proposing two adjustment costs, one of them to sector migration and the other to debt. We also show that when the terms of trade are increased (an increase in world prices of export raw materials), the wage in the raw materials sector is greater than the wage in manufacturing, and therefore, labor flows dynamically to the raw materials sector (Figure 3). Consequently, the manufacturing sector loses labor.

On the other hand, the increase in terms of trade produces a decrease in the stock of physical capital in the manufacturing sector (Figure 4). Thus, the manufacturing sector loses capital and labor. In addition, gross national product decreases, accompanied by an increase in the capital-debt ratio (see Figure 5). In this model, the decrease in labor, capital stock, and production in the manufacturing sector has been defined as direct deindustrialization.

As mentioned in the introduction, one of the mechanisms to decrease the effects of deindustrialization is government tax policy. Thus, the government responds with an increase in the tax rate on the production of the natural resources sector. This causes the wage in the natural resources sector to be lower than that in manufacturing; then, labor in the manufacturing sector increases, and in the raw materials sector, it decreases (Figure 6).

As the work in manufacturing increases, the level of capital in the sector increases (Figure 7). In addition, gross national production increases, accompanied by a decrease in the capital-debt ratio (Figure 8). According to the model built, private debt plays an important role in economic growth, although it has limits, particularly in volatile environments of increases in global interest rates and risk. Basically, foreign savings can increase the domestic capital stock, but this is not enough since the level of debt can increase the levels of income and consumption without promoting an increase in the capital stock. Therefore, the fiscal policy can reverse the deindustrialization process and thereby manage to funnel private debt towards the industrial sector.

The model constructed in this paper does not establish economic growth, except by two tracks. The first would be a constant decrease in terms of trade in the raw materials export sector; this would cause low profitability of the sector and generate a readjustment for the manufacturing sector and expand capital, generating economic expansion.

The second way is to increase the level of technology in the sector. However, the increase in technology in the natural resources sector would cause a reallocation of wages and, with it, an increase in the level of employment for this sector, as well as a decrease in capital and an increase in debt. Therefore, the increase in technology in the manufacturing sector, accompanied by the tax policy, would cause sustained economic growth, the desired effect, because it also decreases the capital-debt ratio.

The model presented here does not establish the mechanism by which the technology (or technological shocks) would grow; it is exogenous to the system. A way to incorporate endogenous such technical change is through learning by doing the process. Basically, the increase in terms of trade causes variation in the movements of world prices of raw materials products, which are exported, and consequently variation in its real exchange rate. With the incorporation of a non-tradable sector, it is possible to show that the increase in the price of primary export goods causes an appreciation of the real exchange rate and indirect deindustrialization, that is, another typical form of the emergence of the Dutch disease.

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